The TACTIC experience: establishing an international, interdisciplinary network to tackle antimicrobial resistance

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The TACTIC Experience: Establishing an International, Interdisciplinary Network to Tackle Antimicrobial Resistance.

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Abstract

Antimicrobial resistance (AMR) is a major global health threat that requires an interdisciplinary international approach to address. In response to calls from policymakers and funders alike, a growing number of research networks on AMR have been created with this approach in mind. However, there are many challenges facing researchers in establishing such networks and research projects. In this article, we share our experience of establishing the network "TACTIC: Tackling AMR Challenges through Translational Interdisciplinary Collaborations". Although presented with many challenges both scientific and logistical, the network has underpinned productive interaction between biomedical and social scientists from several countries and fostered true collaboration in an educative, stimulating and sustainable way that forms a platform for important research on AMR.

Introduction

Antimicrobial resistance (AMR) is a major global health issue. The rise in resistance rates is alarming and an increasing number of countries are reporting bacteria exhibiting resistance to antimicrobials, leading to untreatable and often fatal infections. It is estimated that 6.4 per 100,000 patients infected with a multi-drug resistant organism (MDRO) die each year in Europe (1). Conservative estimates predict 10 million deaths attributable to AMR by 2050, predominantly affecting low- and middle-income countries (LMICs) (2). Left unaddressed, AMR will undermine sustainable development in the health and wellbeing of individuals and societies.

There is wide acknowledgement that addressing AMR requires an international and interdisciplinary, layered approach, that includes biomedical and social science expertise (3,4). However, this is profoundly challenging. First, drivers of resistance are both biological and social processes, the understanding of which requires collaboration between researchers from a variety of natural and social scientific disciplines. While the development of AMR is a biological process, it has been accelerated by a range of social factors, including the increased and unchecked consumption of antibiotics in human and veterinary medicine, farming and agriculture, unregulated pharmaceutical supply chains, globalisation of travel and trade, and migration. Second, the dynamics of AMR span borders requiring collaboration between researchers in different countries. Third, knowledge about the drivers and dynamics of AMR is distributed very unequally across the globe with researchers in LMICs often having fewer resources and less time to research AMR in their own countries.

The latter is problematic from both an ethical and a practical perspective. There is evidence to suggest that LMICs have a higher burden of AMR than high-income countries (HICs) (5), likely due to a range of factors such as lack of compulsory governmental stewardship programmes, unregulated antibiotic consumption in both human health and agriculture,

counterfeit drugs, and limited resources for applying strict infection prevention and control (IPC) measures (6,7). Furthermore, as the drivers and dynamics of AMR are shaped by socio-economic conditions, responses developed in HICs may not be applicable or desirable in LMICs. Finally, whilst HICs currently have lower prevalence of MDROs, globalisation and increased migration are bound to lead to a further spread of AMR globally. There is therefore a need to strengthen interdisciplinary research capacity, in particular with and in LMICs.

In response to calls from policymakers and research funders, a growing number of international and interdisciplinary research networks on AMR have been formed. Some are large in size and have considerable institutional and financial resources, such as the as JPIAMR Dx Global (https://www.jpiamr.eu/amr-dx-global/), TATFAR (https://www.cdc.gov/drugresistance/intl-activities/tatfar.html), and GLASS (https://www.who.int/glass/en/). The majority, however, are small, informal networks of researchers united by an interest in AMR and interdisciplinary approaches. These networks are often not institutionalised and, therefore, less visible. However, they are important as 'bottom-up' initiatives driven by personal initiative and promoting interdisciplinary thinking on the ground. Furthermore, organically grown and building on long-term personal relationships, they can become important building blocks for larger, interdisciplinary projects in the future.

In this short piece, we want to draw attention to such networks as an important part of the emerging ecology of interdisciplinary research. We describe our experiences from setting up the network Tackling AMR Challenges through Translational Interdisciplinary Collaborations' (TACTIC), including its development and sustainability, and some of the challenges we have faced.

Establishing an Interdisciplinary Network

The importance of collaborating in interdisciplinary networks is now recognised among researchers, and funding bodies are increasingly requiring interdisciplinary teams in grant applications. Yet forming such teams and finding researchers from other disciplines to collaborate with is not always straightforward as most networking opportunities still occur within or between closely related disciplines, e.g. clinical medicine and basic science, and they often follow disciplinary patterns.

Many informal networks seem to emerge out of the initiative of individuals who reach out to colleagues from other disciplines. As detailed in Case Study 1, our network goes back to an initiative of two researchers at the University of Sussex, one from the medical school and one from the international relations department, who both work on global health issues. They formed an informal group open to all researchers across the university working on health-related research and called it the Global Health Group. This group created a platform for researchers from the biomedical and the social sciences to meet, learn about each other's work and, importantly, develop personal relationships. Such personal relationships, we have found, are pivotal in helping develop and sustain a network, especially when disciplinary distances are wide. The formation of the network alone is not enough to strengthen and maintain personal relationships, but rather network activities such as joined research questions and projects provide the opportunity for co-working with members of the network and are essential to building relationships based on trust and respect over time. It is through these collaborations that relationships are built and maintained during and beyond the current network.

The Global Health Group has functioned as an important platform for people to connect around more specific research interests, and it was from this group that the idea for an interdisciplinary network on AMR emerged. Members of the Global Health Group formed the 'AMR Study Group' at Sussex and convened a few initial meetings. Working within the field of Global

Health, many of us had established links with researchers in other countries, and we approached these colleagues with the proposal to establish TACTIC when the internal University of Sussex funding call for international research networks was announced (details listed in Case Study 1). The objective of TACTIC was to assemble an international partnership that brought together world leaders in the field of antibiotic resistance (ABR), across interdisciplinary aspects: social and biomedical scientists working together to develop a comprehensive research plan. An important impetus for further collaboration came with the University making available seed funding for interdisciplinary projects related to the Sustainable Development Goals under the Sussex Sustainability Research Fund (SSRP) (8). Members of the TACTIC, together with partners from Egypt, successfully applied and obtained these funds, and began working together on a project exploring the 'lifecycle' of AMR data from an interdisciplinary perspective (Case Study 2)(9).

The availability of research funding was important for the development of the network because it provided a focus for collaboration and an incentive to develop a concrete interdisciplinary project.

The availability of platforms that facilitate and promote networking is important in achieving successful interdisciplinary research. However, those platforms are often set-up by individuals, which can lead to difficulties in sustaining this type of network. In recent years, funding bodies, universities, and scientific societies have responded to this problem and created seed funds for researchers to pilot interdisciplinary network development. These types of funds enabled us to start engaging with colleagues from a variety of disciplines and countries on the issue of AMR. It is also important to note that international conferences, meetings and courses provide researchers with opportunities to network and form potential future collaborations.

Interdisciplinary 'grand challenges'

Working across different sets of expertise and disciplinary backgrounds can be hugely rewarding as it can open up new ways of seeing the world. For instance, from the perspective of a social scientist focussing on human behaviour, it has been revelatory to learn about the world of bacteria and their continuous adaptation to different micro-environments. Similarly, it has been important to comprehend just how much uncertainty there is about the biology of AMR and how it affects human health. For researchers in the medical/microbiological field, it has been interesting to understand how AMR can be approached from a non-medical perspective, looking beyond the diseases and genetics of the organisms, and employ methodologies to study how behaviours affect health-care workers' approach to and understanding of AMR, and how this can affect antibiotic prescribing practices and adherence to IPC policies.

Yet different conceptual and methodological lenses and un-encountered terminologies can also make cross-disciplinary communication difficult, and the wider the range of disciplines included in the collaboration, the more challenging this becomes (see Box 1 Logistical Challenges). For instance, learning new terminologies and trying to comprehend different methods and perspectives takes time and effort, as does explaining one's own language and approaches to colleagues from other disciplines.

It is difficult to account for this time and effort through conventional workload allocation models employed by many universities. Similarly, most network and seed funding schemes do not account for this effort; researchers' time is usually not compensated for and the focus is on funding meetings and travel. Meetings are important, but they need to be prepared in order to be effective. Effective preparation includes not only logistics (which, in itself, can be time-consuming, especially when many people from different countries are involved), but also continuous communication between network members before and after face-to-face

gatherings. Such communication is essential to keep the momentum going and develop ideas and concrete proposals to be discussed at the face-to-face meetings.

Network funds seem to rely on the research time that most UK universities allocate to their staff. Yet there is often a mismatch between formally allocated research time and the actual time available that academics have to conduct research, with teaching and administrative requirements often taking over. This mismatch can be exacerbated when network participants hold more than one small grant, with none of them paying for their time. In LMICs, this situation tends to be even more difficult. Here, allocated research time is rare, and research tends to be funded by either external scientific and donor organisations, or it is conducted in people's private time and supported by private resources. The ability to establish and maintain interdisciplinary collaboration, therefore, depends significantly on the time and resources available to individual researchers.

Another challenge we encountered concerns the translation of network activities into specific research projects and outputs. Even under the best conditions and with complete engagement in interdisciplinary learning, it can be difficult to link the conception of a problem developed in one discipline to that developed in another. For instance, genomic research highlights the importance of gene exchange and transmission between bacteria to understand the evolution of resistance, whereas political analysis has shown how regulatory and fiscal frameworks incentivise or deter the development, production, and use of antibiotics. While the genetic evolution of bacteria can be shaped by the availability of antibiotics, it is very challenging to conceptualise the link between regulatory frameworks and bacterial evolution in a way that both disciplines can operate with, and to develop a methodological approach that advances research in both fields. While many researchers recognise that, in principle, there is a need for interdisciplinary research (10), it can be difficult to translate this consensus into specific

191 projects. As a result, interdisciplinary research on AMR often takes the form of either a
192 biomedical project with a social science 'add-on', or vice-versa.
193 Differences between disciplines reveal themselves also in the institutional context within which
194 researchers operate. For instance, it is often more difficult and, therefore, time-consuming to
195 have interdisciplinary projects assessed by ethical review boards as they tend to be organized
196 along broad disciplinary lines. Similarly, career paths often follow disciplinary trajectories. For
197 instance, journals with high impact ratings in one discipline can be entirely unknown in another
198 and, therefore, inadequate to the eyes of promotions boards. Equally, authorship rules can vary
199 vastly between disciplines. While most social science publications are authored by one or two
200 people, publications in the biomedical sciences often include several authors. Hence, the
201 contributions of social science researchers publishing multi-authored papers is difficult for
202 their peers in the social sciences to assess.
203 Moreover, rules of authorship 'sequence' differ between disciplines. Social sciences
204 publications tend to name authors in alphabetical order, reflecting more or less equal
205 contributions of researchers to co-authored publications. In the biomedical sciences, the most
206 relevant authors are named either first or last (corresponding to the researcher who
207 wrote/drafted the manuscript, and the principal investigator of the study, respectively), and
208 other authors who have contributed to the manuscript are listed in-between in relation to their
209 contribution to the work. However it is important to note that many biomedical journals now
210 require a statement of the individual contributions of each author to the manuscript. It can,
211 therefore, be difficult to reconcile these differences in a way that publications 'count' equally
212 for members from different disciplines.
213 One result is that most interdisciplinary work is published in disciplinary journals, where
214 disciplinary perspective dominates, and the publication counts little for team members from
215 the other disciplines. However, not everyone can afford this. For instance, early-career

researchers (ECRs) and the (increasing) number of researchers on fixed-term contracts have to make every publication count. This is equally true for many researchers based in LMICs, who encounter more challenges discussed below.

Internationalizing interdisciplinary research on AMR

When we were looking for research partners for the project on the lifecycle of AMR data in Egypt (see Box 2), we found that AMR was seen almost exclusively as 'a medical problem' investigated mainly by academics from microbiology and pharmacy, and by clinicians. Interdisciplinary approaches to researching AMR, which are so strongly promoted in the UK, were not on the agenda of Egyptian academics working on AMR. In fact, the institutional difficulties of interdisciplinary research that we described above with regard to the UK are exacerbated in many LMICs: there are few platforms for researchers from different disciplines to interact, and career and publication paths are even more rigidly structured along disciplinary lines.

For the UK group, this created the problem of finding local partners with a background in the social sciences and an interest in working on AMR. It was necessary to hold local workshops in Egypt to introduce the idea of interdisciplinarity in general, and the details of the project to academics in Egypt (who mainly came from medical backgrounds). An advertisement for a research assistant post was disseminated across our contacts in Egypt, and we were extremely fortunate to find collaborators from the biomedical sciences who were interested in an interdisciplinary approach, and to find a medical researcher with a background in the social sciences who was able to conduct social science research within the country.

Different country capacities and infrastructures for interdisciplinary research can raise questions about the ownership of the 'interdisciplinary model' of AMR research. From our experience working in North Africa, AMR is studied primarily from a (bio)medical

241 perspective, leaving a big gap for social science-related data. Engagement between social
242 scientists and those in the natural sciences and/or medicine is very limited as discussed above.
243 For instance, it can create dependence on researchers and funding bodies from countries where
244 such resources are available, thereby generating issues of agenda-setting, ownership and
245 sustainability. Some of these issues have received considerable attention in the field of research
246 ethics, but it can be challenging to address them in the context of an actual collaboration.
247 Professional respect and personal relationships can make it difficult to point out such
248 inequalities. Furthermore, they may be felt more acutely by some team members than others.
249 One way to address this is building in mechanisms of knowledge exchange, technology transfer
250 and capacity strengthening. The TACTIC network has undoubtedly increased the capacity of
251 all its members to understand and engage with other disciplinary perspectives on AMR, and
252 thereby helped foster a shared sense of ownership of the interdisciplinary agenda. The most
253 important activities for this were face-to-face meetings and the collaborative research project
254 on the lifecycle of AMR data. Since 2016, TACTIC members have come together in meetings,
255 where we explained our ongoing work and research interests, identified areas where we feel
256 we would benefit from interdisciplinary collaboration, and discussed potential collaborative
257 projects. While there was a common recognition of the relevance of different disciplinary
258 perspectives and strong interest in interdisciplinary collaboration, these meetings also revealed
259 the challenges of developing common research questions and combined conceptual and
260 methodological approaches.
261 Just as important as regular face-to-face meetings has been the development of a small
262 research project that involving seven members of our network. Funded by the SSRP project
263 at the University of Sussex, the project traces the lifecycle of AMR data in a Cairo hospital
264 and contextualises this in the wider field of global AMR governance. To understand how the
265 problem of AMR presents itself at a local hospital, we collected bacterial isolates from

patients with bloodstream infections. We also conducted interviews with hospital staff to understand their perceptions of and information about AMR. In addition, we analysed policy documents to understand how global AMR initiatives, such as WHO's Global Antimicrobial Resistance Surveillance System (GLASS) and the Global Health Security Agenda, attempt to build on data collected at the local level. The experience of working on a concrete project in a team comprising clinicians, microbiologists and political scientists from Egypt and the UK has contributed greatly to our understanding of what it means to work across disciplines. It has also helped building specific skills on the part of individual network members. For instance, one project member with a medical background embarked upon a Master's degree in public policy during the project and was able to apply some of the conceptual and methodological skills from the Master's programme in our research project. Our commitment to capacity building has allowed us to provide training opportunities and enhance the skills for researchers from Egypt in Sudan in whole genome sequencing (WGS) and molecular microbiology across the TACTIC network, either through local workshops or research tuition (Box 3).

The SSRP project has revealed some of the challenges of conducting interdisciplinary research on AMR, especially in countries where there is even less funding and infrastructure for this than in the UK and other high-income countries. It has also highlighted the importance of trustful personal relationships in conducting such research.

The opportunities and challenges of small networks

Small networks such as TACTIC tend to be based on individual initiative of researchers looking to form a fruitful collaboration, shared common interests and respectful personal relationships. These 'ingredients' have been key for overcoming many of the challenges we encountered in interdisciplinary and multi-country work. For instance, it helped overcome

291 difficulties in understanding each other across both disciplinary and country backgrounds and
292 helped create a sense of trust that the initial commitment would pay off. Personal relationships
293 and shared research interests, which often originated from previous collaborations, proved to
294 be important also in generating trust that resources and data (such as interview transcripts
295 and/or bacterial samples and any subsequent results/outputs) would be shared equally and
296 fairly. It is difficult to recommend an optimal number of members within a network, as this
297 will largely depend on the objectives and aims of the network and how they can be achieved.
298 TACTIC was composed of 15 researcher, and we aimed for diversity in disciplines, skillsets,
299 backgrounds, and experiences. A further advantage of being in a relatively small network is
300 that most members have an active role and have contributed to the outputs detailed in Box 3.
301 It may be difficult to achieve and maintain this 'equal activity' in larger networks, where certain
302 members will be more outspoken (and heard), while others will not be as active.
303 The small size, however, brings creates its own challenges. One such challenge lies in type of
304 funding that is available to maintain such networks, which tends to exclude compensation for
305 people's time. As mentioned above, networking – especially across different disciplines -
306 requires time, and freeing up people's time from competing obligations could make the entire
307 investment more productive. For instance, if a small group of network members were able to
308 have even a small percentage of their time paid for, they could dedicate this time to developing
309 larger research proposals through which the network could develop and be financially
310 supported. This would also help address a second problem of sustainability as small networks
311 tend to be funded through small and short-terms grants. As the case of TACTIC illustrates,
312 small grants can be catalytic to get a network off the ground and trial research collaborations,
313 but their limitation in terms of resources and time makes it difficult to develop and
314 institutionalise collaboration in the long run. Institutionalisation is, however, critical for
315 sustainability. First, it creates continuity that does not depend on the ability of individuals to

316 contribute (which may change depending on other commitments as well as personal and
317 professional developments). Second, institutionalised relationships can greatly facilitate the
318 ability to acquire larger grants, where the financial and other stakes are high, and which always
319 require significant institutional backing and support. [See Box 1 for some of the logistical
320 challenges we encountered].
321
322 **Case Study 1**: Developing an interdisciplinary network
323 Global Health is a research priority at the University of Sussex and local expertise in this area
324 spans different schools and departments, including Medicine, Global Studies, International
325 Relations, Development Studies, and Anthropology. Until 2016 each department worked as
326 silos. To unite these specialities a study group was created by researchers to share common
327 interests in Global Health. AMR was a common research interest among the Global Health
328 Group described above which lead to the establishment of the Sussex AMR Group
329 (http://www.sussexamrgroup.org/) which aims to provide a platform to generate transformative
330 knowledge through interdisciplinary collaborations. The group holds regular meetings to share
331 research expertise, engage in new ways of thinking about critical issues, and to develop
332 partnerships, projects, and publications aimed at a range of audiences, in order to address the
333 challenge of AMR. Each member not only brought their own expertise, but also pre-existing
334 global collaborations.
335 Successful joint application to the 'International Research Partnerships and Networks Fund',
336 an internal University of Sussex funding stream, provided an opportunity for this group to
337 consolidate a formal research network and strengthen existing international collaborations in
338 Spain, Germany, Egypt and Sudan. The overarching aim of the **T**ackling **A**MR **C**hallenges
339 through **T**ranslational **I**nterdisciplinary **C**ollaborations (TACTIC) network was to assemble an
340 international partnership of experts in the field of AMR. Reflecting this, our objectives were to

(i) advance the understanding of drivers of AMR, (ii) strengthen interdisciplinary AMR research and (iii) enhance AMR research in LMICs. To achieve these aims we brought together researchers with expertise in relevant areas (genomics, epidemiology, infection, biomedical science and international relations and anthropology) to create a united bio-social approach to develop and implement relevant research questions to tackle AMR (See Figure 1 for details). Since 2016, TACTIC successfully achieved its objectives which are outlined in Box 3.

Case Study 2: Building Global Surveillance with Local Data: an example of an interdisciplinary project

The establishment of TACTIC enabled the researchers to think of ways in which to combine the diverse expertise within the network to create a research project. Developing a truly interdisciplinary research project is, however, a tremendous challenge because it requires the development of common questions and an integrated methodological approach, both of which need time, personal commitment and the space to explore and test this collaboration. Through the TACTIC meetings, generating high quality data was identified as a common priority across all the disciplines, and has a particular importance in LMICs, as lack of data is often the main hindrance for generating funds for research projects to improve knowledge in low-resource settings. Funding was obtained through the Sussex Sustainability Research Programme (also a University of Sussex internal funding scheme) for an interdisciplinary pilot project with the objectives to 1) tracking the 'life-cycle' of data on AMR that is produced in routine clinical practice in Egypt, and 2) follow its trajectory in local healthcare facilities, the health system and the policy level. The overall aim was to use these data for future strategic locally-relevant projects to strengthen AMR capacity in Egypt. In particular, this project aims to produce genomic data for clinically important pathogens (11) (*Acinetobacter baumannii*, *Klebsiella pnuemoniae*, *Staphylococcus aureus* and colistin-resistant Gram-negative organisms) via

whole-genome sequencing, as well as investigating the local healthcare workers' perspective on AMR and how the data are used to inform local, national and international policies.

Reflections, Conclusions, and Future Plans

It is widely acknowledged that we need interdisciplinary research involving, in particular, researchers from LMICs in order to address the rise of AMR. Indeed, resources for such a research approach have increasingly been made available in many HICs, yet collaboration spanning a wide range of disciplines is exceedingly challenging conceptually, methodologically and institutionally. These challenges make interdisciplinary research exciting as they speak to the very essence of research: curiosity and the desire to learn, improve health, and explore. To this end the increasing resources that have been made available for such projects have greatly facilitated interdisciplinary endeavours. However, the costs of engaging in such collaboration still fall largely on the individual, making it more difficult for ECRs, those on fixed-term contracts (who are often ECRs as well), and researchers based in LMICs. These groups, however, are absolutely critical to drive cutting-edge research of truly global relevance. It is therefore vital to further invest in a research environment that reduces the costs of interdisciplinary collaboration for the individuals, by funding networking activities, high-risk projects trying out new methods and approaches, outlets for publications, including those reporting on what has not worked, as well as long-term institutional funding for interdisciplinary research, especially in LMICs. Addressing the challenges of interdisciplinarity (conceptual, methodological and institutional boundaries), requires a long-term and sustained approach.

For the reasons outlined above, it remains an exciting time to work in the field of AMR. Based on our experience, we recommend that a successful interdisciplinary research network requires a broad-range of expertise, provides opportunities for networking and capacity building, while

391 maintaining equal and sustainable contributions, as well as taking into account any logistical
392 obstacles such as geographical dispersal, culture diversity, and language barriers. The goal of
393 TACTIC is to provide a platform for interdisciplinary research in AMR, addressing issues
394 collectively with an overall aim of proposing solutions to improve IPC globally. We believe
395 TACTIC successfully achieved its short- and medium-term goals. To maintain sustainability
396 and growth of TACTIC, we continue to expand the network to other countries and other
397 disciplines e.g. public engagement, medical education, and medical anthropology, as well as
398 work on generating further larger proposals and research projects among the group.
399 In conclusion, it is vital for researchers to interact within and beyond their disciplines, as this
400 enhances and knowledge transfer and fosters a constructive research environment (see Box 2).
401 It is important that individual researchers feel supported by their teams and institutions to
402 undertake interdisciplinary research. AMR needs a coordinated interdisciplinary approach
403 where the biological factors of resistance are studied in combination with the social factors
404 contributing to their dissemination in both the healthcare and community settings. The
405 objective is to build capacity, and help create locally-relevant interdisciplinary research that
406 will eventually reduce the disease burden, and aim to deliver impact both locally, regionally,
407 and globally by encouraging engagement, communication and dissemination of findings to the
408 global research community.

Box 1: Logistical challenges

1- Language:

Language is a major challenge faced in international interdisciplinary research, particularly due to the differences in scientific languages used by different disciplines. As outlined above, interdisciplinary research requires commitment from researchers to explain their own disciplinary language in addition to learning new terminologies, methodologies and perspectives from other disciplines.

Although English is the international language of science it can be difficult for non-native speakers to express themselves accurately in it. In our experience however, the network consisted of researchers from diverse backgrounds who were comfortable communicating in English, with several members sharing a common native language (e.g. Arabic, German, Spanish), where they sometimes supported each other if needed. Increased exposure to the academic community (through engagement and outputs) would significantly enhance the communication skills of individuals, hence TACTIC's commitment to facilitating training, networking and conference attendance of ECRs from LMICs. In addition, the small size of the TACTIC network and the fact that several network members have known each other for years has facilitated active participation of all members during meetings.

2- Travel restrictions:

Whilst attending meetings and conferences to facilitate networking is important, it can be difficult for researchers, particularly from LMIC due to relatively high costs and visa restrictions. The geographical widespread location of researchers can be difficult in international collaborations.

Therefore, frequent meetings must be planned for the maintenance and success of the network and collaboration, in person or via online portals. In our experience with TACTIC,

we relied mostly on face-to-face meetings. We learnt the value of setting achievable timelines and goals for the network to ensure the maximum benefit for everyone. Furthermore, as seen in figure 1, TACTIC meetings were planned in different network member countries to ensure inclusivity and to engage with the wider research community locally. However, it is important to note the increasing popularity and usefulness of online meeting tools/facilities to facilitate international networking activities without the need for travelling. Some local restrictions on security may exist on certain tools, so it is important researchers are aware of such issues.

3- Access to and sharing of data:

Accessing international LMIC institutes' laboratories and hospitals can be challenging for researchers outside of the institution, and certainly for foreigners, due to the requirement for local approvals. This of course poses a challenge in obtaining appropriate approvals (e.g. ethics, institutional review board) due to issues around access to, ownership of, and availability of the data and any subsequent outputs. In our experience with TACTIC, there was committed to working with local researchers on any projects, provided detailed plans on how the data were going to be collected and stored and by whom (their affiliation & position) were provided. Also there was a requirement that data and outputs were locally relevant to all stakeholders, with an overall aim of use in enhancing local policy in infection prevention and control. Research proposals and methodologies were planned and executed collectively by the team members.

Box 2: Strengths of international interdisciplinary networking

In our experience international interdisciplinary networking has led to:

- insights into different disciplines within and between countries
- experience with qualitative and quantitative research
- experience with different (research) cultures
- development of communication skills (across scientific, cultural and language barriers)
- development of leadership skills
- strengthening capacities for interdisciplinary work among all network members and strengthening specific technical capacities particularly for network members from Egypt and Sudan
- providing researchers with involvement in research opportunities outside of their discipline

Box 3: Outputs of TACTIC to date:

1. Created an interdisciplinary network of international researchers.
    1.1. Network sustainability is maintained through meetings at international conferences, and also through a number of follow-on project applications.
2. Established collaborative locally-relevant research projects in Egypt and Sudan.
    2.1. Funding for two AMR research projects in Egypt and Sudan.
    2.2. Promoted the importance of social science research for addressing AMR among biomedical researchers in Egypt and Sudan.
        2.2.1. A project in Egypt (Case Study 2) using social science research methods to investigate healthcare workers' understanding and perception of AMR in the hospital.
        2.2.2. Working in collaboration with social scientists on a project in Sudan looking at antibiotic consumption practices in the community.
3. Held six workshops and meetings across the network countries (Figure 1).
4. Provided a platform for knowledge and expertise sharing through a number of meetings and research projects.
    4.1. Supported South-South collaborations between local institutions in Egypt and Sudan.
5. Supported training, mentorship and capacity building for ECRs in areas such as microbial genetics and epidemiology, and training on genome sequencing methodology across the network.
6. Provided an opportunity for cultural exchanges for all the network members.

Figure 1: Timeline of Events for TACTIC Meetings and Activities

TACTIC meetings were held across the different collaborating countries as seen in the figure. The meetings were usually 2-3 days, aimed to provide a wide range of talks from social as well as (bio)medical scientists, each on their perspectives and experiences in AMR. Generally, the first day would involve guest speakers with experience in conducting interdisciplinary projects in AMR, to enhance external collaborations. This was followed by a team meeting where we discussed progress and future plans for the network. In addition to the meetings indicated above, network members met at a number of international conferences. Furthermore, TACTIC provided research tuition training in molecular microbiology and Next-Generation-Sequencing (NGS) to a number of researchers from Egypt and Sudan at Brighton and Sussex Medical School, Brighton and Sussex University Hospitals NHS Trust, and the University of Cologne. This is in addition to participation in two workshops held in Cairo (in August 2017 and November 2018) on mobile genetic elements (MGEs), and applications of NGS. Numerous virtual meetings also took place between members on specific research areas/projects. However, for the wider group, we relied on in-person meetings.

TACTIC members are continuing the successful collaboration on a number of follow-on projects. Details of outputs are outline in Box 3.

Reporting requirements for the IRPN was 4 times quarterly, whereas with the SSRP it was biannually. Reporting was uncomplicated as despite the overlaps, the projects were separate, with distinct aims, and achievements. The SSRP project stemmed from the establishment of TACTIC, but had a specific research question relating to data, whereas TACTIC was a general research network.

IRPN: International Research Partnerships and Networks

SSRP: Sussex Sustainability Research Programme

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Conflicts of interest

Authors declare no conflict of interest